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Autoregressive neural network approach to the total ozone concentration time series over Kolkata, India

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Evolution of the ozone layer is significantly influenced by the changes in the climate. By ozone layer one means the lower region of the stratosphere, where the ozone concentration is relatively higher than the other layers. Changes in the transport process, chemical composition and temperature in this layer very often results from the variations in the climate [1]. Enhancement in the greenhouse effect has led to an increase in the tropospheric ozone concentration since 1900. A time series is a particular realization of a stochastic process. A stochastic model is a structured expression of a stochastic process. Markov chain and autoregressive models are examples of stochastic models, and these have been of vital importance in studying meteorological processes, and a handful of works of literature are available where time series for variables associated with meteorological processes have been investigated through stochastic models [2]. This study reports univariate modeling methodologies applied to the monthly total ozone concentration (TOC) over Kolkata, India, derived from the measurements made by the Earth Probe Total Ozone Mapping Spectrometer (EP/TOMS). In the present work, the data collected from measurements made by EP/TOMS.

In the present work, the two forms of univariate model have been generated. The models are autoregressive integrated moving average (ARIMA) and autoregressive neural network (AR-NN) [3]. Three ARIMA models in the forms of ARIMA(1,1,1), ARIMA(0,1,1) and ARIMA(0,2,2) and 11 autoregressive neural network models, AR-NN(n), have been generated for the time series of total ozone under consideration. Considering the periodicity of 12 months in the time series, 11 AR-NN(n) models have been generated. In each model, the best set of inputs has been selected through tan exhaustive process of variable selection. For example, of AR-NN(5) may be considered. The complete input matrix in this case consists of 103 (108 – 5= 103) rows and five columns, where the five columns correspond to the daily TOC concentration data for five consecutive days. The target output matrix has the order 103X1, where the column contains the TOC of the sixth day. The training : test cases is 7:3 and it has been validated over the entire study set based on the method of round robin. Assessment of models have been carried out through the test of the goodness of fit of the models to the time series of monthly TOC using prediction error, Pearson correlation coefficient, and Willmott's indices. After a thorough skill assessment, the best predictive model comes out to be the ARIMA (0,2,2) for the TOC time series under consideration.

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